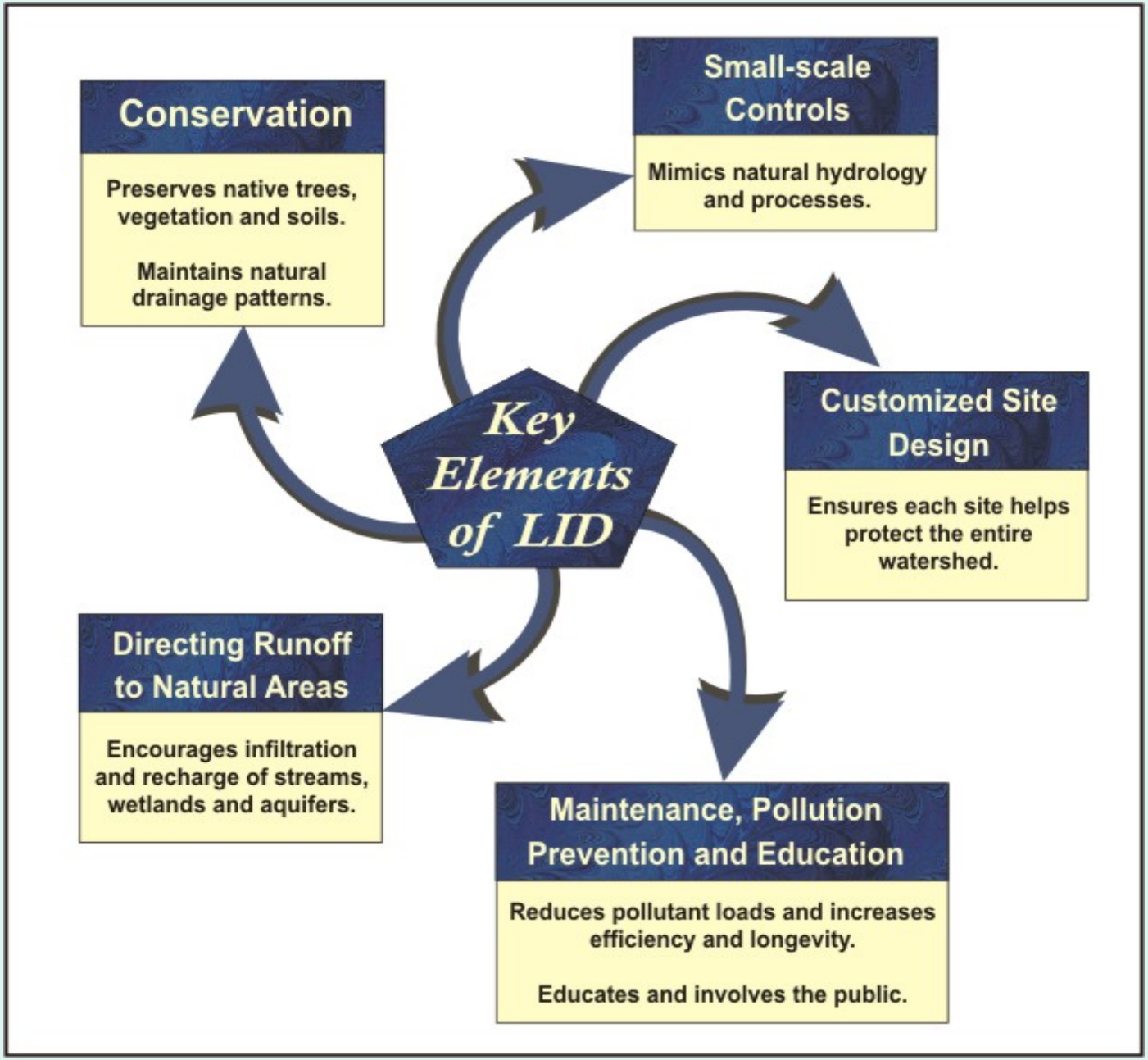
Low Impact Development: Focusing on Water Quality

City Creeks Division
2008

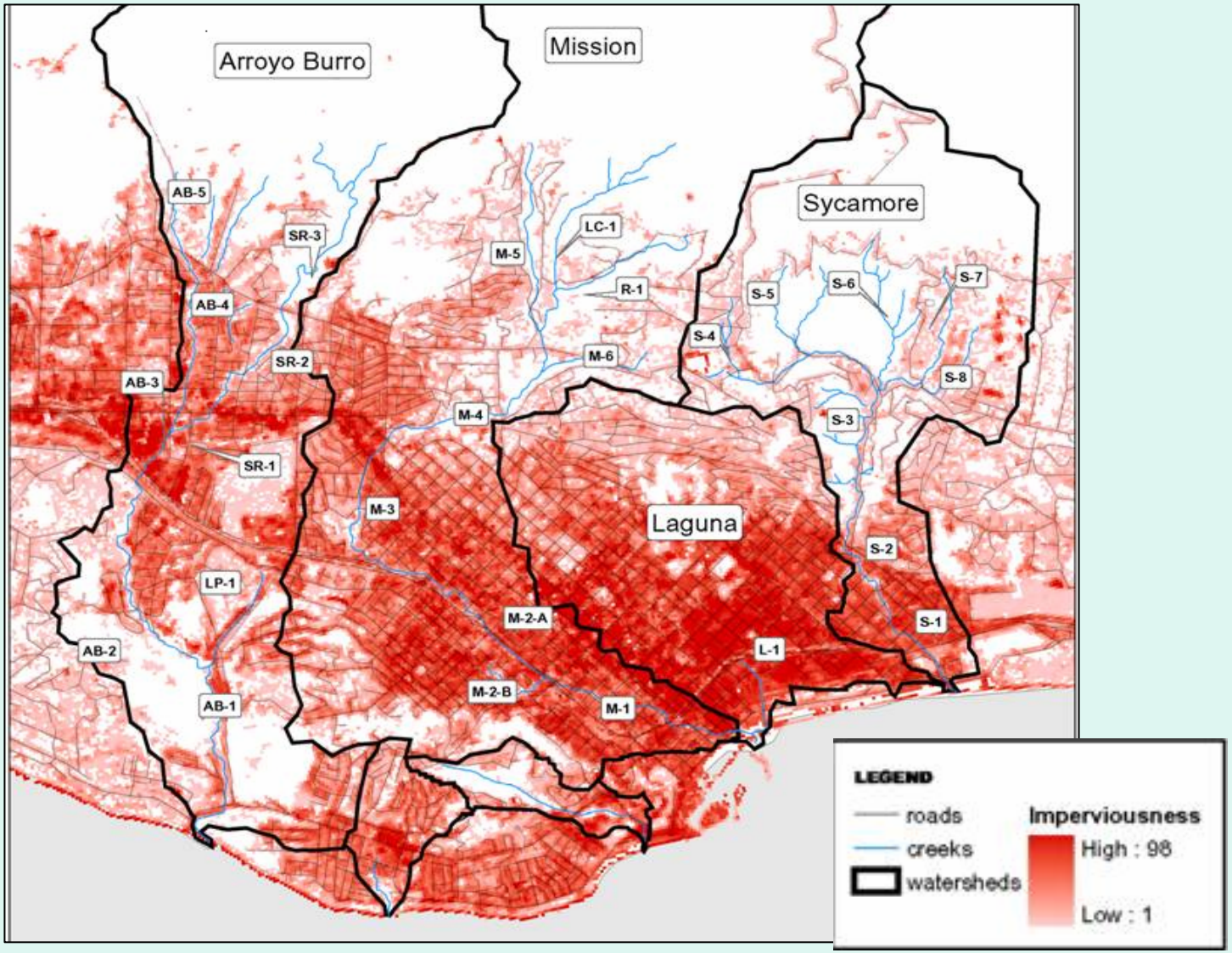
What is "LID?"

- ***Site development with ecology and storm water management in mind***

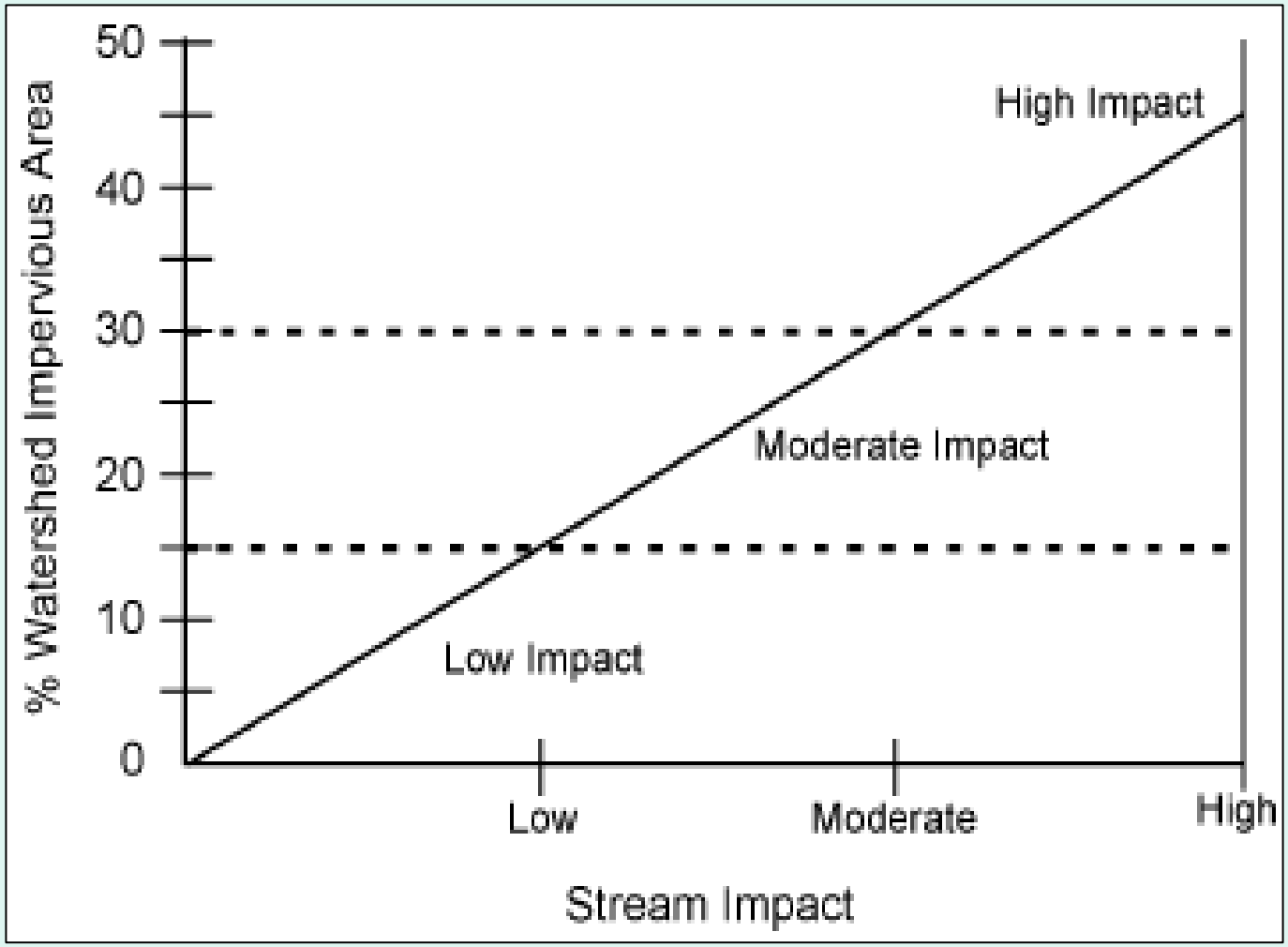
- Conserves or replicates pre-development hydrology of a site
- Maximizes pervious surfaces
- Disconnects impervious surfaces
- Emphasizes source control
- Uses natural functions to capture/treat
- Biological removal of pollutants through plants and soils
- Focuses on cost-effective techniques
- Reduces storm water runoff volume
- Decreases runoff velocity
- Improves water quality


Conservation
Preserves native trees, vegetation and soils.
Maintains natural drainage patterns.
Small-scale Controls
Mimics natural hydrology and processes.
Key Elements of LID
Customized Site Design
Ensures each site helps protect the entire watershed.
Directing Runoff to Natural Areas
Encourages infiltration and recharge of streams, wetlands and aquifers.
Maintenance, Pollution Prevention and Education
Reduces pollutant loads and increases efficiency and longevity.
Educates and involves the public.

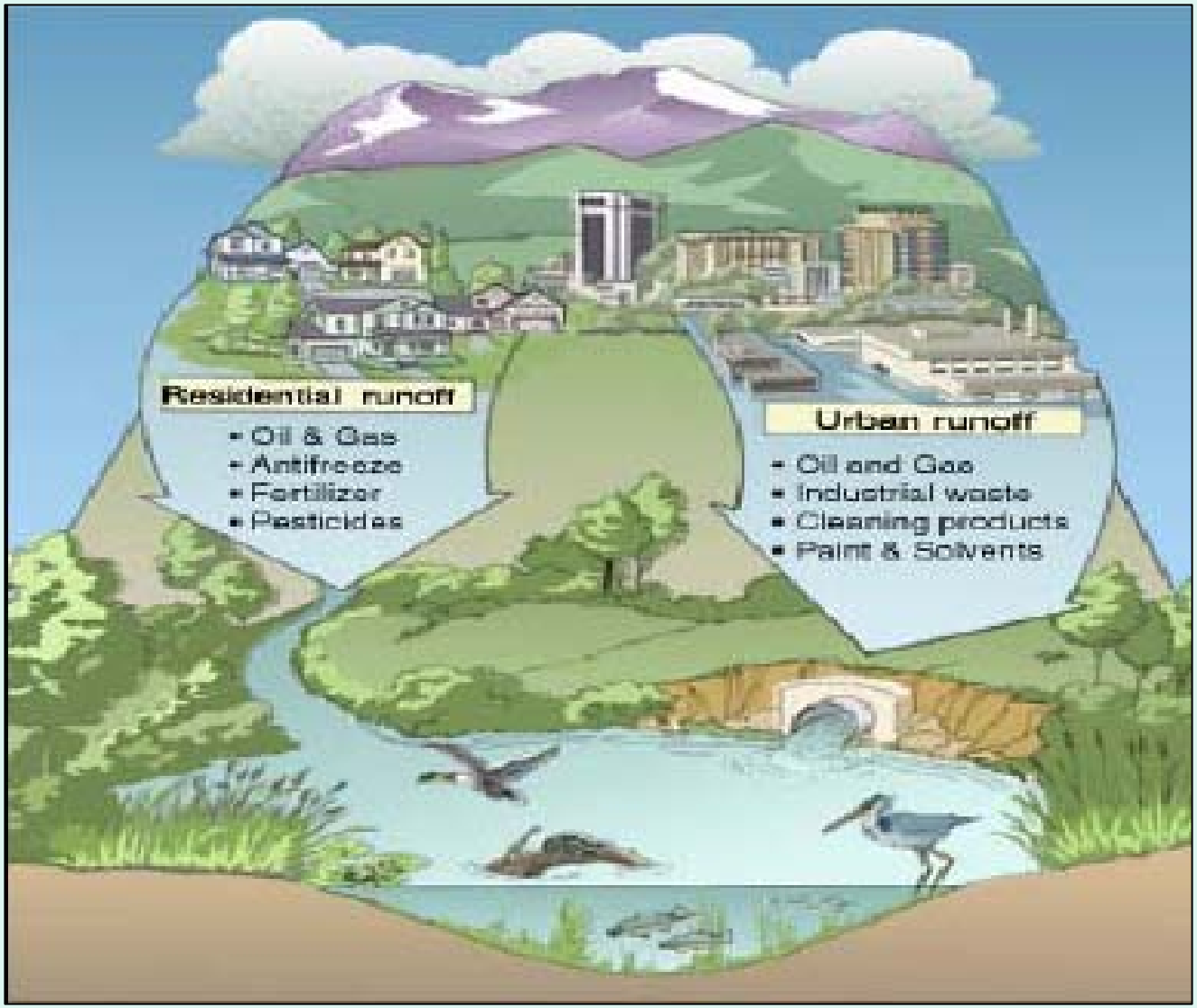
Santa Barbara Impervious Surfaces



Imperviousness Impact on Water Quality



Runoff: Quantity and Quality



Some LID Solutions

- By capturing smaller storms (1” of rainfall) and allowing it to percolate into the ground, soil and plant biology “treats” polluted water naturally
- Groundwater and aquifer recharge is increased
- Peak water flow through drainage channels is reduced
- Flooding and erosion is minimized

LID Techniques

- Redirecting down spouts to vegetation or rain barrels/cisterns
- Bioretention (Infiltration or "flow through")
  - Grass strips/swales
  - Bioswales
  - Rain gardens
  - Tree box filters/planter boxes
  - Curb cuts
- Detention Basins / Dry wells
- Green Roofs
- Pervious Concrete / Permeable Pavers

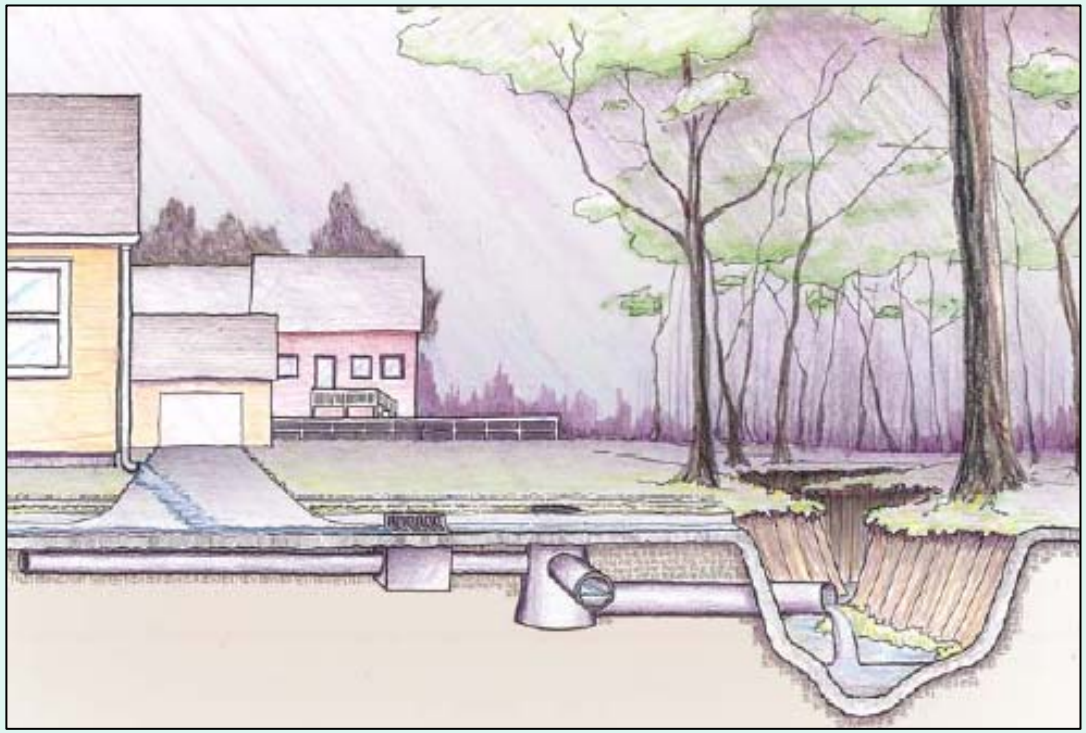
Detention Vs. Retention

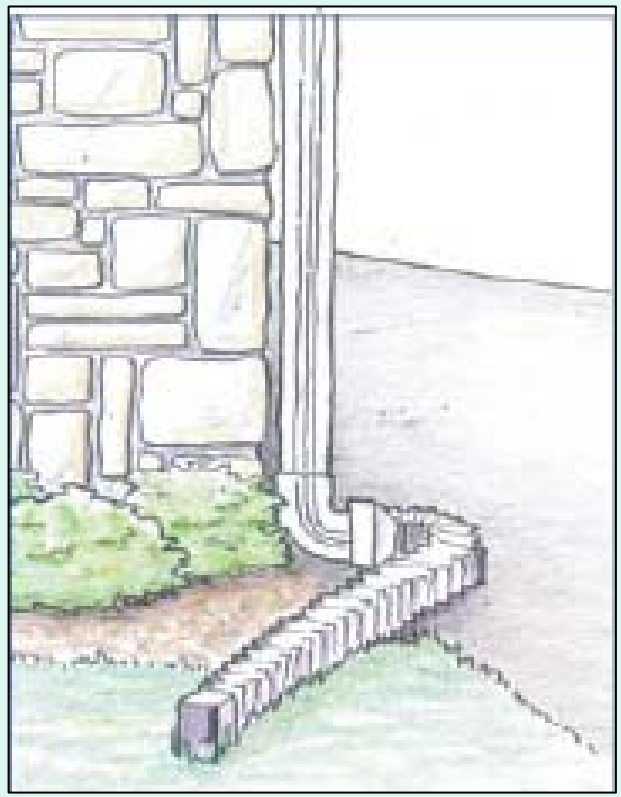
All LID practices implement water detention and/or retention…

- DETENTION: temporary, short-term storage of storm water
- RETENTION: storm water is stored indefinitely (and ideally infiltrated into the ground)

Redirect Down Spouts:

To The Yard...





Redirect Down Spouts:
Rain Barrels/Cisterns

Rain Barrel/Cistern Design

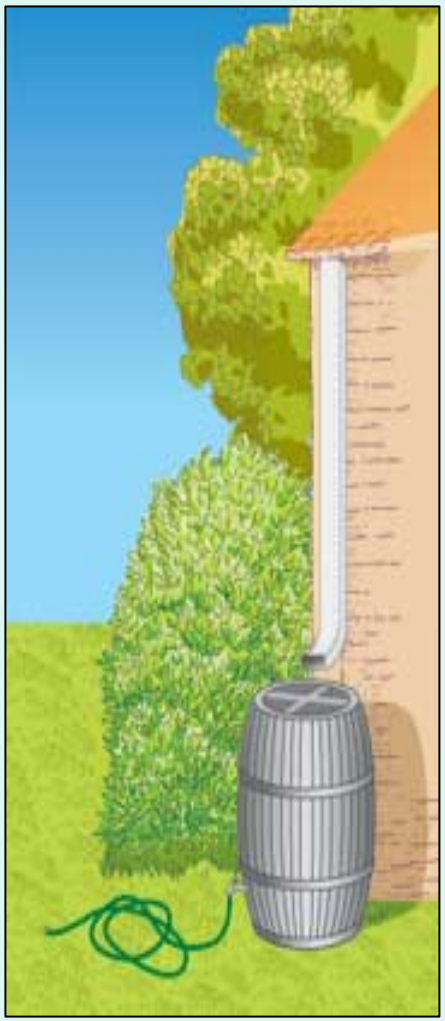
A general rule of thumb: 1 inch of rainfall on a 1000 square foot roof will yield approximately 600 gallons

Rain Barrels/Cisterns

Storm Water Benefits:

- Reduces runoff volume
- Delays and reduce peak flow rates
- Easily maintained
- Applicable to residential, commercial and industrial sites
- Good solution for common site challenges that pose restraints for other LIDs
- Conserves potable water
- Low cost

Redirecting Downspouts



It's inexpensive!

The designs are simple – you can do it on your own!

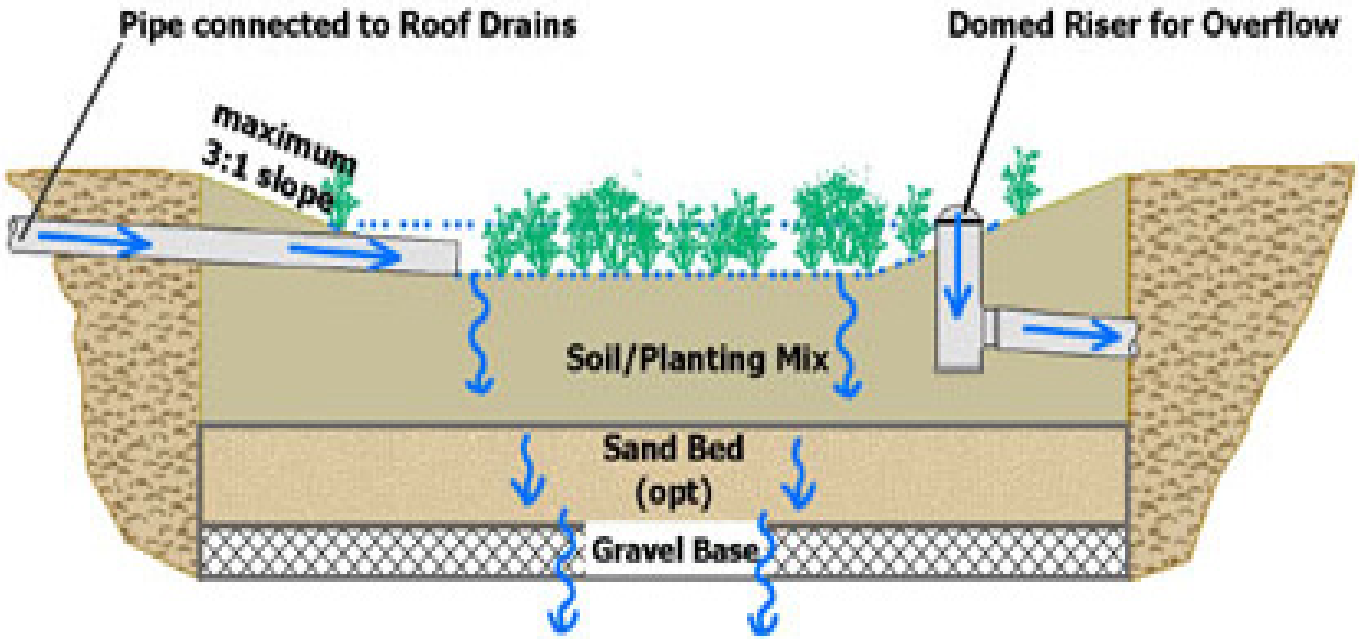
…Or, buy inexpensive downspout extensions or purchase a rain barrel for as little as $50.00 (depending on your capacity needs)

Bioretention

Bioretention

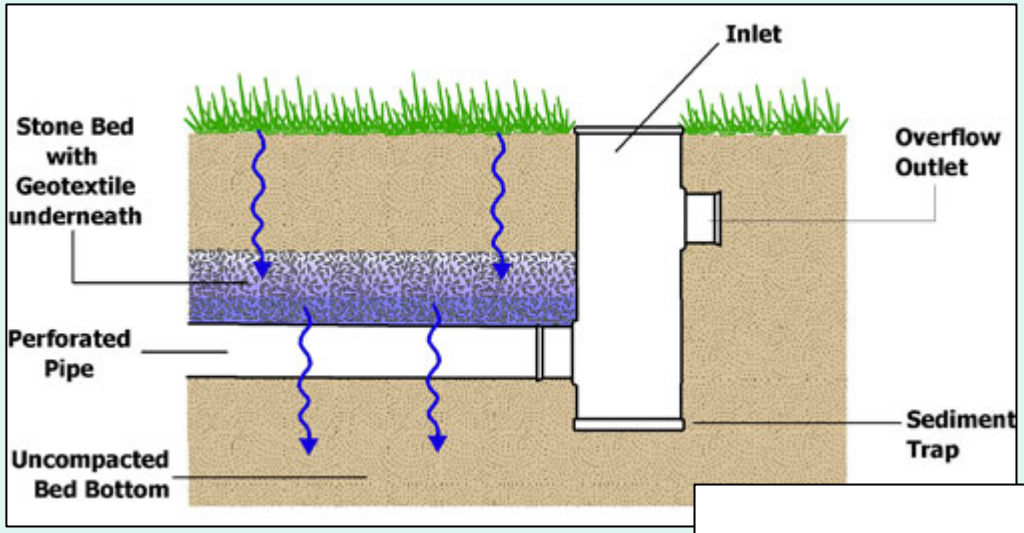
Bioretention

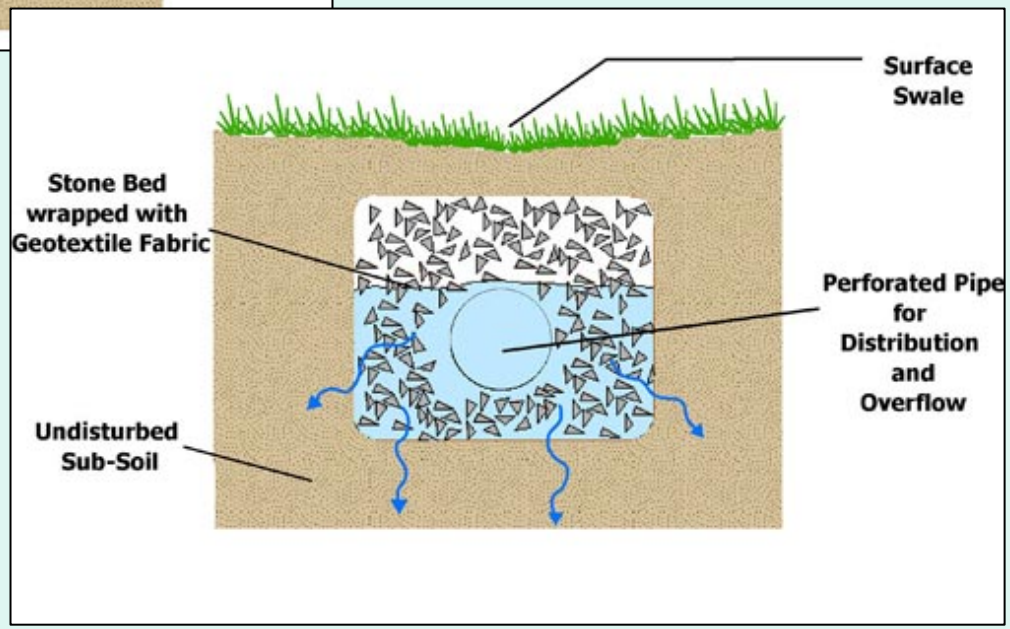
Bioretention Design



Geotextile fabric must line the bed to prevent groundwater contamination.
Sand bed and/or gravel base are optional features that depend on existing soil conditions.

Bioretention Design





Bioretention

Storm Water Benefits:

- Effective in reducing runoff volume
- Infiltration treats storm water through soil and plants
- Removal efficiencies good for metals and nutrients
  - Lead: 70 – 90%
  - Copper: 43 – 97%
  - Zinc: 64 – 98%
  - Phosphorus: 0 – 87%
  - Nitrogen: 0 – 92%
  - Ammonium & Nitrate: 0 – 26%

Detention Basins

Underground

These are dry detention basins; they only hold water during storms

Above Ground

Detention Basins

These are wet detention basins; designed to hold water

Detention Basins

Storm Water Benefits:

- Can be designed to infiltrate ***or*** detain
- Slows storm water runoff
- Reduces peak discharges/flooding
- Can save space (can be designed as strips or placed underground)
- Dry detention basins can be used as green open space
- Captures sediment and toxins associated with particulates
- Can be easy and inexpensive to construct and operate

Green Roofs

Roof of City Hall, Chicago, Illinois

Green Roofs

Ford Motor Company, Irvine, CA

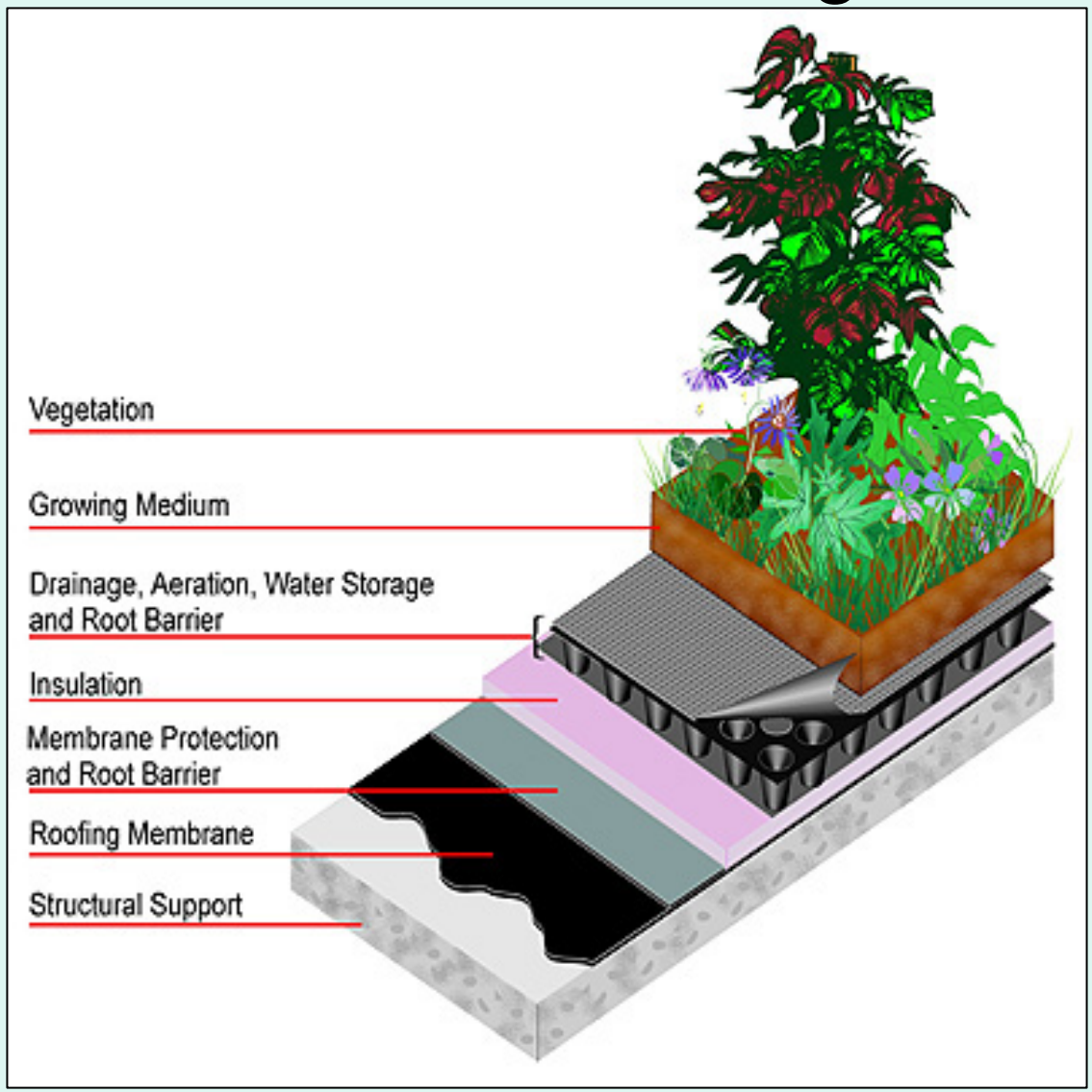
2.3 acre shopping mall green roof,
Providence, Pennsylvania

Green Roofs

Corporate golf! (putting green)

Herb garden, Vancouver Waterfront Hotel

Green Roof Design

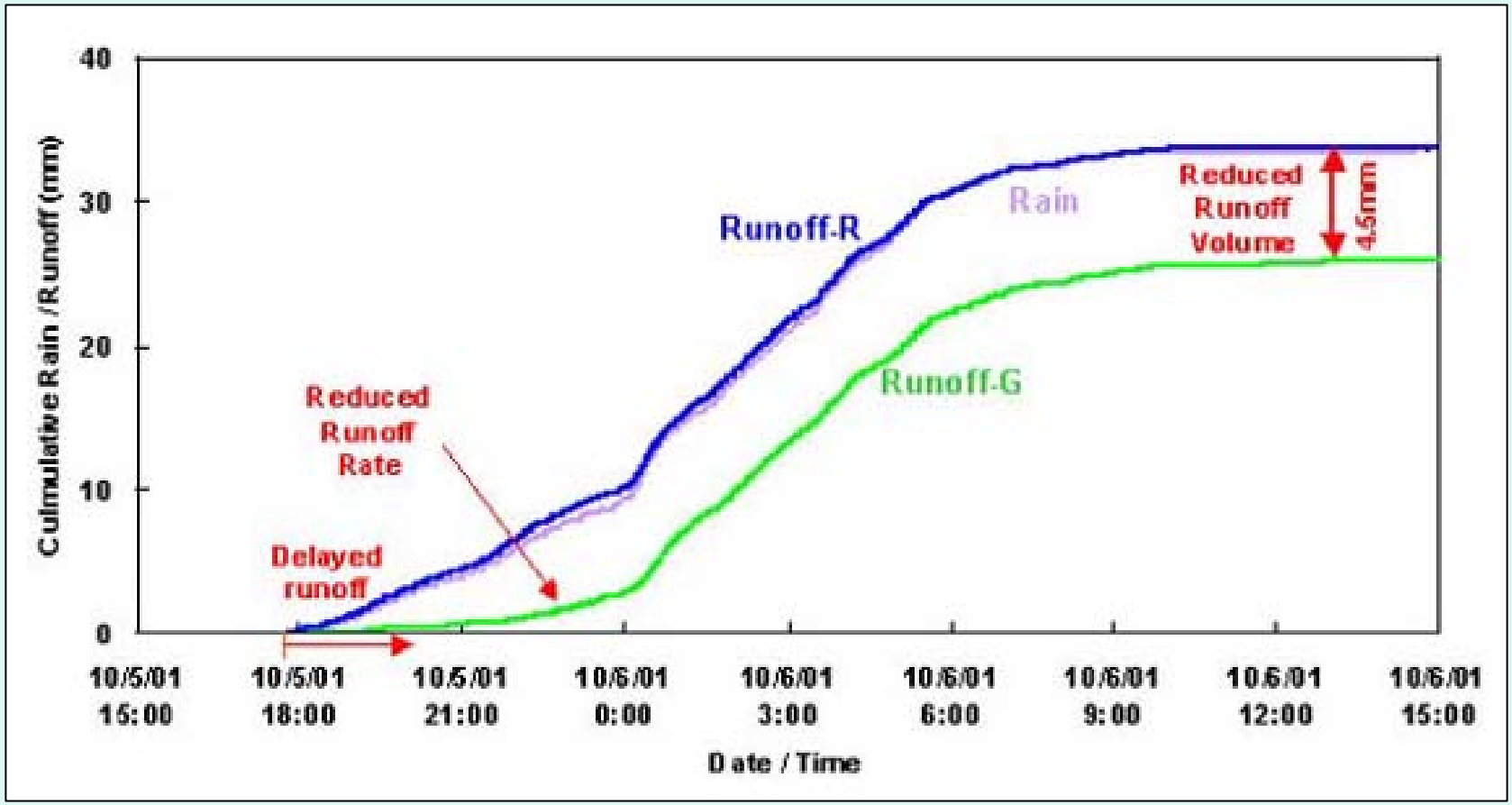


Green Roofs

Storm Water Benefits:

- Water is stored by roof substrate
- Water is used by plants/returned to atmosphere; transpiration/evaporation
- A green roof with 2 - 8 inches of growing medium can hold approx. 4 - 6 inches of water
- Acts as natural filter for water run off
- Reduces the amount of runoff
- Delays the time at which runoff occurs
- Decreases stress on storm water systems at peak flow periods

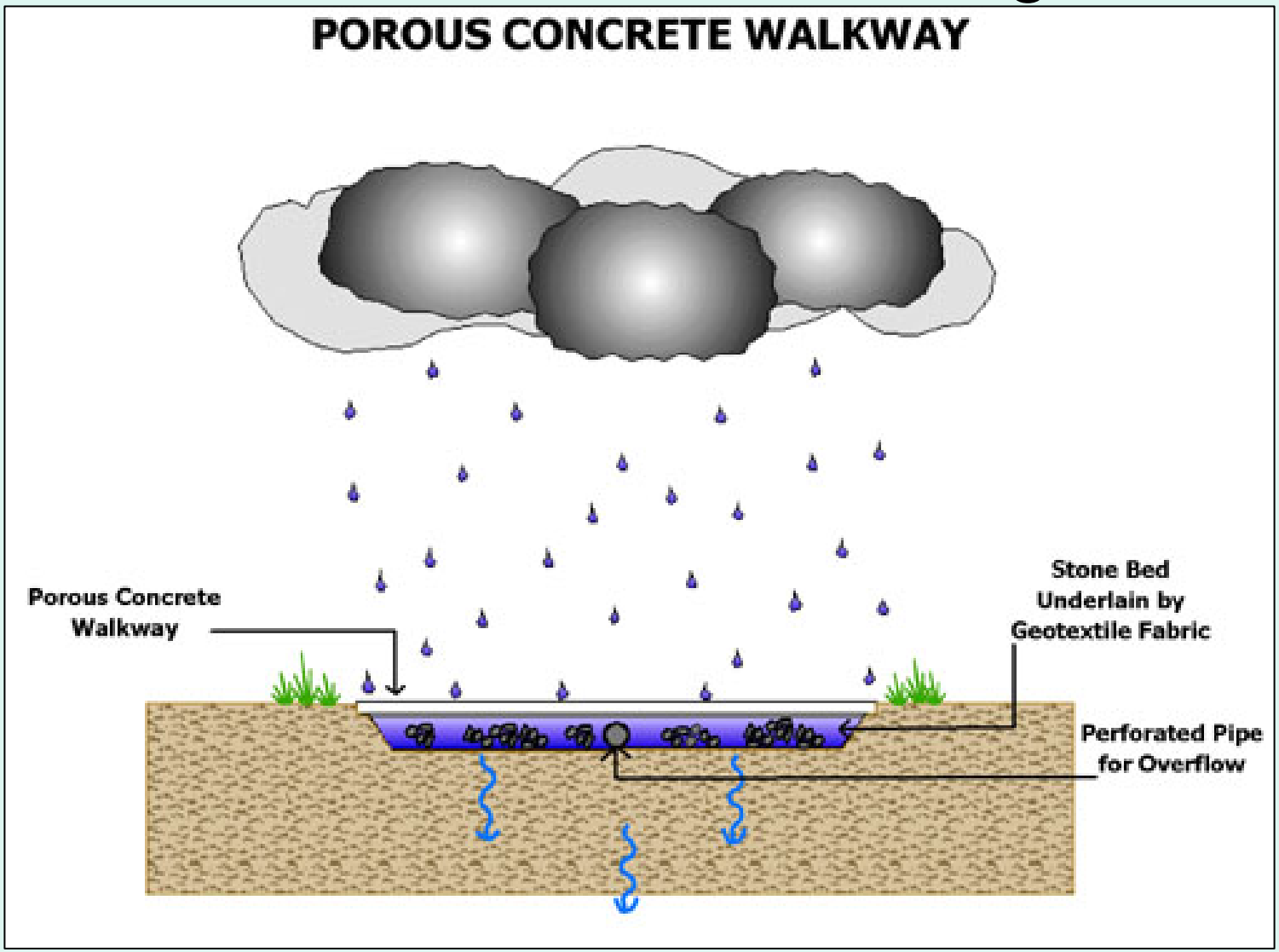
Green Roof Runoff Improvement



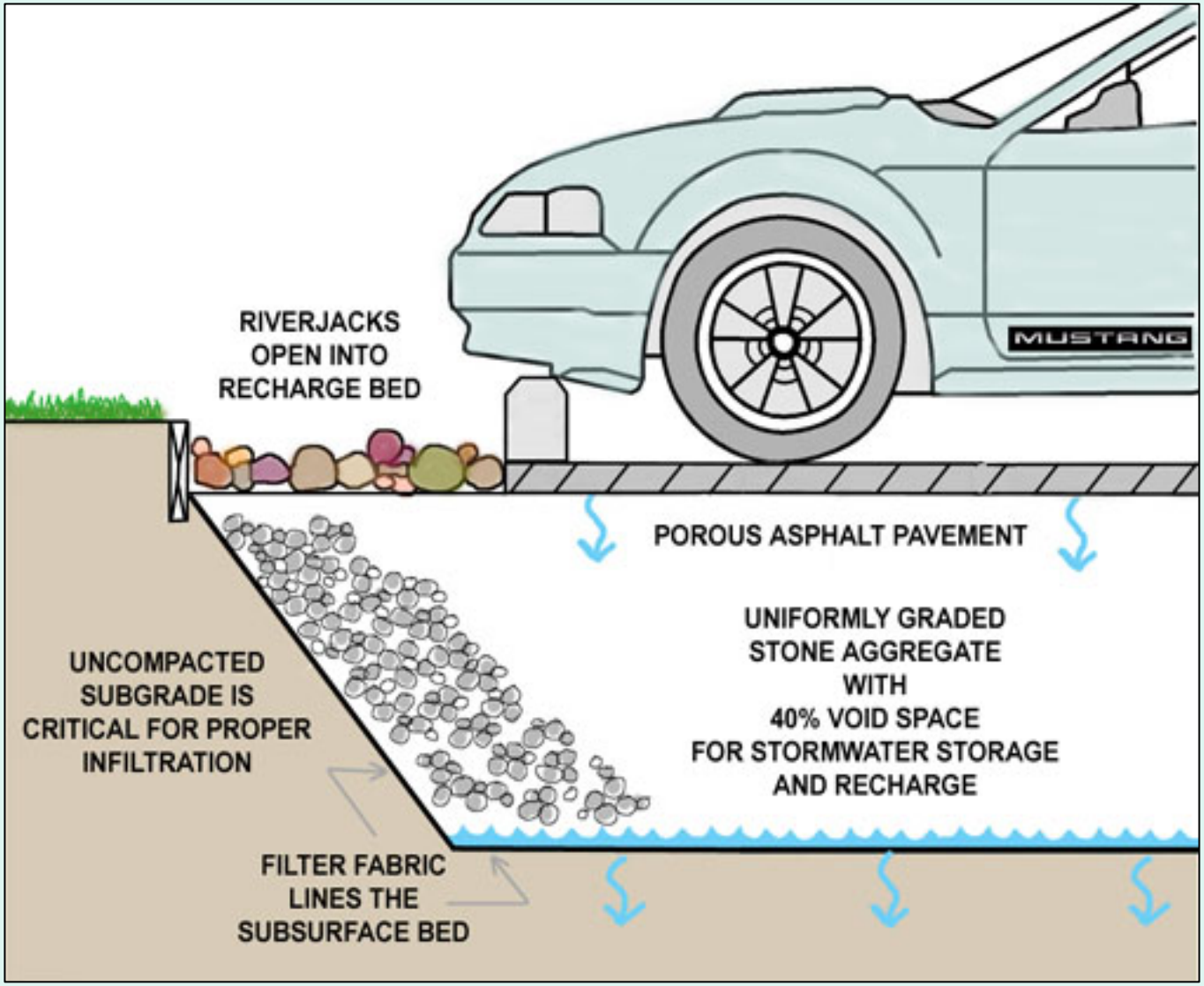
Pervious Pavers

Pervious Concrete

Pervious Concrete Design



Porous Asphalt/Pavers Design



Pervious Concrete/Pavers

Storm Water Benefits:

- Storm water retention areas are reduced or eliminated, allowing increased land use
- Designed to capture and treat hydrocarbons
- Light color and open pore structure absorbs less heat
- Allows trees to receive more air and water

Effectiveness of Porous Pavement Pollutant Removal, % by mass*

Study Location	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)	Chemical Oxygen Demand (COD)	Metals
Prince William, VA	82	65	80	—	—
Rockville, MD	95	65	85	82	98–99

**Schueler, 1987, as quoted in EPA, 2004.*

Local Low Impact Development

Hayward Design Center

Casa Nueva

Local Low Impact Development

Ampersand

South Coast Watershed
Resource Center

Local Low Impact Development

City Bioswale at the end of Soledad Street

Cost Benefits

December 2007 - EPA summarized 17 case studies of developments that include LID practices and concludes:

- Applying LID techniques can **reduce project costs** and improve environmental performance

- In the vast majority of cases, **significant savings** were realized due to reduced costs for site grading and preparation, storm water infrastructure, site paving, and landscaping

- Total capital cost savings ranged from 15 to 80 percent when LID methods were used

Cost Benefits

Project	Conventional Development Cost	LID Cost	Cost Difference[b]	Percent Difference[b]
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	–$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c]	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

[a] The Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs study results do not lend themselves to display in the format of this table.
[b] Negative values denote increased cost for the LID design over conventional development costs.
[c] Mill Creek costs are reported on a per-lot basis.

Cost Benefits

LID can save $$ because:

- Total volume of runoff to be managed is minimized
- Reduced materials and infrastructure
- Hard infrastructure (curbs, gutters, and piping) are replaced with natural drainage features, engineered swales and vegetated contours
- By infiltrating or evaporating runoff, LID techniques can reduce the size and cost of flood-control structures

Challenges

- Change from the "status quo"
- Clay soils
- Steep slopes
- High groundwater table
- Conflicting goals/policies
- Maintenance
- Enforcement

City Progress Toward LID

- **Technical Guidance Manual** for Post-Construction Storm Water Management
- Creeks Division allocating **funds in the FY 2009 budget** for LID demonstration projects (concept, design, permitting, construction)
- Council adoption of **Ahwahnee Water Principles** for Resource Efficient Land Use

Ahwahnee Water Principles

The Ahwahnee Water Principles focus on practices that reduce runoff from urban development and encourage recycling of water:

- Implement compact community design
- Preserve open lands and waterways
- Incorporate "water holding areas" into urban landscapes
- Recharge groundwater
- Reduce or retain runoff
- Improve water quality
- Use permeable surfaces for hardscape

Resources/Links

http://www.dot.ca.gov/hq/construc/stormwater.html

http://www.cabmphandbooks.com/

http://www.nrdc.org/water/pollution/storm/

http://www.stormwatercenter.net/

http://www.lowimpactdevelopment.org/

http://www.**lid-**stormwater.net/

http://www.epa.gov/nps/**lid**/

Questions?